Technical Note

Fingerprint Powders: Aerosolized Application Revisited

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Abstract: Investigators are frequently faced with the task of processing crime scenes where the evidence cannot be readily shipped to the laboratory for analysis. In such cases, the investigator typically relies on fingerprint powders to develop latent print impressions. Conventional methods of fingerprint powder application can increase the possibility of damaging or destroying latent print impressions primarily by the application of too much powder. An alternative method of applying fingerprint powder to the surface using an aerosol spray has been introduced in the past, but yielded unsatisfactory results. Modifications in formulation and aerosol technology have rendered this technique a viable alternative, making it a less challenging and a more convenient method of applying fingerprint powder. Aerosol spray helps to control the amount of powder released while maintaining an even distribution onto the surface and decreases the amount of brush contact with the substrate surface needed to fully develop the impression thereby lessening the chance of damaging the impression. Furthermore, this method exhibits no adverse effects on deoxyribonucleic acid (DNA).

Introduction

The application of powders for the development of latent fingerprints is one of the earliest known techniques dating back to the nineteenth century [1]. The constituents of latent print residue facilitate the adherence of powder particles thereby rendering impressions visible. Developed impressions are then preserved by lifting or photography.
Over the years, a number of different methods of powder application have been proposed. The most common method of application for conventional powder dusting is brushing the surface with appropriately bristled brushes such as animal hair or fiberglass [2, 3]. Other, less popular methods have been proposed such as atomizers, sifting, and aerosolized spray, but, traditionally, the results are typically inferior to the standard method of dusting with brushes [2–4].

The atomizer method of applying fingerprint powders consists of applying the fingerprint powder onto the substrate surface by a blast of air, thus reducing the need for physical contact, which may destroy or damage ridge detail. The blast of air from an atomizer charged with powder is not in itself strong enough to develop an impression fully, and thus still requires brushing to enhance the print. In addition, atomizers have a tendency to paint the surface for two reasons: (1) the inability of the atomizer to deliver an even spread of powder and (2) the strength of the air forces the powder into the surface depressions [3].

The sifting method of applying fingerprint powders consists of applying powder directly onto the substrate to be processed and then sifting the powder back and forth until enough powder adheres to develop any latent impressions. A fingerprint brush may still be necessary to remove excess powder [2] because this method often results in too much powder being applied to the surface, thereby destroying or overpowdering the print.

The aerosolized method of applying fingerprint powders could be a more practical and efficient technique, especially for the novice; because it requires less skill and experience, it makes it less challenging and needs less training [2]. The concept of aerosolized application is theoretically sound because there is minimal physical contact between the applicator and the impression, thus lessening any chance of damaging or destroying latent print ridge detail [3]. Proper awareness and control of ventilation is a necessity with this application. Not only does it affect performance, but excess airborne fingerprint powders can contaminate surrounding areas. Airborne powder can be a health concern because of the negative effects on the respiratory system [3, 5–7]. Aerosol powders have been used in the past without very effective results, ultimately contributing to the abandonment of the technique, primarily because of improper formulations causing nozzles to clog and uneven spray distribution [2], poor powder-to-propellant ratios [3], and improper air control. Recent
modifications to the technique addressed the powder and propellant mixtures, controlling and reducing airborne particles, and maintaining an even spray distribution. This research revisits the use of aerosolized powders for latent print development as a proof of concept study by assessing whether these problems have been resolved by the updated modifications and evaluating the resultant quality and usefulness of the technique as an alternative method for the application of powder.

**Materials and Methods**

Four commercial fingerprint powders – grey (Sirchie, Youngsville, NC), white (Evident, Union Hall, VA), black (Evident, Union Hall, VA), and fluorescent (Redwop, Lightning Powder Company, Inc., Jacksonville, FL) – were each placed in separate small, medium, and large aerosol cans (Enamelite, LLC, Clarksville, TN) and filled to reach specific powder masses of 1 g, 4 g, and 7 g, respectively, maintaining a similar powder-to-propellant ratio (proprietary) for all cans. This study was conducted in a controlled laboratory environment where conditions were monitored using a temperature and humidity meter (Extech Instruments, Mashua, NH). The ambient temperature and humidity were 72.5 °Fahrenheit and 21%, respectively.

A commercial sebaceous control matrix standard (Armor Forensics #1-2792) was used for the deposition of the latent print impressions on two types of nonporous substrates – smooth and lightly textured plastic. Thirty-six latent print impressions were deposited on each type of substrate for each particular deposition age – 0 days, 7 days, and 14 days. Fingers were washed using soap and water prior to matrix loading. The fingerprint matrix was loaded onto the study participant’s thumb by rubbing against the sebaceous matrix standard pad using a consistent format for each deposition. The depositions consisted of twelve depletion series of three successive latent prints each. An additional 12 gradients were processed with cyanoacrylate ester fumes (CNA) prior to the application of powders. Each of the 24 gradients (12 gradients processed with CNA and 12 gradients without) were subjected to development by each of the four particular powders distinguished by the three aerosol can sizes containing the specified powder mass per can. The application of the aerosolized powders for each of the latent print impressions was as follows:

1. An isolation device – a small, cone-shaped paper with openings at each end – was placed over the area
containing the test impression to constrict the powder application to the desired area.

2. Each aerosol can was shaken for 10 to 15 seconds to thoroughly mix the elements and maintain the same consistency of powder distribution.

3. The aerosol spray was directed into the isolation device and a single burst was sprayed for approximately 1/3 second (Figure 1).

4. The powder was allowed to settle for approximately 10 seconds prior to removing the isolation device (Figure 2).

5. The area with the test impression was lightly dusted with a fiberglass brush (Evident #1008) to develop the impression fully and to remove excess powder deposition (Figures 3, 4).

Figure 1
A single burst of powder is being applied directly into the isolation device that covers the area containing the latent print impression.
Figure 2

The powder settles in the isolation device and reveals an outline of a latent print impression that may be further developed by dusting.

Figure 3

The area containing the latent print impression is lightly dusted using a fingerprint brush in order to develop the impression fully.

Figure 4

The fully developed latent print impression using white powder applied from the aerosol spray can on a clear plastic surface with a black background.
All latent print impressions developed were digitally captured using a Nikon D2Xs digital camera under automatic exposure conditions prior to a visual analysis of the printed images (Xerox Phaser 7750DN PS), which was carried out by nine certified latent print examiners. Under single-blind procedures, each certified latent print examiner judged the developmental quality of each of the 432 latent print impressions according to the clarity of the developed impression by assigning a numerical rating on a scale from zero to five based on the following:

0 = No development
1 = Poor development; ridge structure unclear
2 = First-level detail; visible pattern type with unclear ridge path configurations
3 = Second-level detail present; visible ridge path configurations
4 = Good development; clear and distinct ridge path configurations
5 = Excellent development; clear ridge path configurations with distinct ridge and pore structure

Additionally, each examiner was provided with the following definition for clarity:

Clearness, i.e., how well friction skin detail is recorded in a print. In other words, “How well the details from 3-D ridges are reproduced in the 2-D print is referred to as the clarity of the print. When most of the detail found on the friction ridges is reproduced in the friction ridge print, the print is considered clear. If few of the details from the friction ridges are reproduced, the print is considered unclear.” [8]

All images were presented to each examiner in a format so only the study coordinators were aware of the image identity. Data was recorded and plotted for statistical evaluation and interpretation.

Lastly, taking into account the need of a chemical propellant to expel the powder from the aerosol container, the destructive potential to deoxyribonucleic acid (DNA) was investigated using buccal swabs. Because the same formula of aerosol propellant was used for all cans, one aerosolized powder can was used to spray directly onto the buccal swabs at a distance of one inch. The buccal swabs were analyzed by the USACIL’s DNA Branch using standard DNA quantification, amplification, and typing procedures.
Results

The ratings given by the examiners for each image were averaged and statistically evaluated using the student’s t-test (95% confidence) to compare the results of the powder development according to substrate type, powder type, prior processing, deposition intensity (depletion series), can size, and impression age. Impressions receiving an average rating of 3.0 or higher were considered to be suitable for identification purposes. The potential for an adverse effect to DNA was analyzed by the USACIL’s DNA Branch.

Substrate Type

An overall comparison of the developmental quality of the impressions on smooth versus textured surfaces for each specific age of impression is shown in Table 1. These results indicate no significant difference in the overall rating for those impressions developed on either substrate for each age (Figure 5).

<table>
<thead>
<tr>
<th>Age</th>
<th>Smooth</th>
<th>Textured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>3.3 +/- 0.2</td>
<td>3.4 +/- 0.3</td>
</tr>
<tr>
<td>Day 7</td>
<td>2.8 +/- 0.2</td>
<td>2.5 +/- 0.4</td>
</tr>
<tr>
<td>Day 14</td>
<td>2.6 +/- 0.3</td>
<td>2.2 +/- 0.4</td>
</tr>
</tbody>
</table>

Table 1

An overall comparison of the developmental quality of the impressions on smooth versus textured surfaces for each specific age (95% confidence).

Figure 5

Image on left demonstrates quality of development of Day 0 white powder previously processed with CNA on smooth surface. Image on right demonstrates quality of development of Day 0 white powder previously processed with CNA on lightly textured surface.
**Powder Types**

Table 2 compares the developmental quality of the impressions based on powder type for each specified age. The highest quality of development came from both the grey and white powders, which had relatively equal quality ratings compared to each other across all ages. Fluorescent powder followed in developmental quality behind the white and grey powders. The developmental quality of the impressions developed with black powder were notably lower than the remaining powders for each age to a statistically significant degree ($P < 0.001$) (Figure 6).

<table>
<thead>
<tr>
<th></th>
<th>Grey</th>
<th>White</th>
<th>Black</th>
<th>Fluorescent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>4.0 +/- 0.3</td>
<td>4.2 +/- 0.2</td>
<td>2.1 +/- 0.3</td>
<td>3.1 +/- 0.4</td>
</tr>
<tr>
<td>Day 7</td>
<td>3.2 +/- 0.5</td>
<td>3.4 +/- 0.4</td>
<td>1.3 +/- 0.3</td>
<td>2.8 +/- 0.4</td>
</tr>
<tr>
<td>Day 14</td>
<td>2.9 +/- 0.4</td>
<td>2.9 +/- 0.5</td>
<td>1.3 +/- 0.3</td>
<td>2.5 +/- 0.4</td>
</tr>
</tbody>
</table>

Table 2

*An overall comparison of the developmental quality of the impressions developed with various powders for each specific age (95% confidence).*

**Figure 6**

*Images demonstrate quality of development of Day 0 impressions developed with various color powders not previously processed with CNA on lightly textured surface. Image A is developed with grey powder. Image B is developed with white powder. Image C is developed with black powder. Image D is developed with fluorescent powder.*
Prior Processing

For the impressions processed with and without CNA, Table 3 demonstrates a comparison of the overall ratings between those impressions for each specific age. The results show that impressions not processed with CNA prior to powder application maintained a more consistent developmental quality across all ages, whereas those that were processed with CNA exhibited a considerable drop in quality to a statistically significant degree past Day 0 ($P < 0.001$) (Figure 7).

<table>
<thead>
<tr>
<th></th>
<th>CNA</th>
<th>Non-CNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>3.0 +/- 0.3</td>
<td>3.6 +/- 0.2</td>
</tr>
<tr>
<td>Day 7</td>
<td>1.9 +/- 0.2</td>
<td>3.4 +/- 0.3</td>
</tr>
<tr>
<td>Day 14</td>
<td>1.6 +/- 0.3</td>
<td>3.2 +/- 0.2</td>
</tr>
</tbody>
</table>

Table 3

An overall comparison of the developmental quality of those impressions previously processed with and without CNA (95% confidence).

Figure 7

Images demonstrate quality of development of Day 14 impressions developed with white powder on lightly textured surface. Image on the left is previously processed with CNA. Image on the right is not previously processed with CNA.
Deposition Intensity (Depletion Series)

For each of the three successive deposition intensities (depletion series) per age, Table 4 breaks down the average ratings for each deposition. Overall, the quality of development decreased with each successive deposition intensity, yielding a statistically significant difference between depositions 1 and 3 for each age ($P < 0.01$) (Figure 8).

<table>
<thead>
<tr>
<th></th>
<th>Deposition 1</th>
<th>Deposition 2</th>
<th>Deposition 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>3.5 +/- 0.3</td>
<td>2.7 +/- 0.4</td>
<td>2.5 +/- 0.4</td>
</tr>
<tr>
<td>Day 7</td>
<td>3.4 +/- 0.3</td>
<td>2.8 +/- 0.4</td>
<td>2.4 +/- 0.4</td>
</tr>
<tr>
<td>Day 14</td>
<td>3.1 +/- 0.4</td>
<td>2.6 +/- 0.4</td>
<td>2.2 +/- 0.4</td>
</tr>
</tbody>
</table>

Table 4
An overall comparison of the developmental quality on successive deposition intensities (amount of matrix available for development) (95% confidence).

Figure 8
Images demonstrate quality of development of Day 0 impressions developed with white powder previously processed with CNA on lightly textured surface. Image A demonstrates the quality of deposition 1. Image B demonstrates the quality of deposition 2. Image C demonstrates the quality of deposition 3.
Can Size

A comparison of the quality of the impressions developed using each can size filled with specific amounts of powder (small can: 1 g powder, medium can: 4 g powder, and large can: 7 g powder) for each particular powder is illustrated in Tables 5 through 7 separated by age. These results indicate that for the grey, white, and black powders, a difference in the can sizes and powder masses did not affect the quality of development to a significant degree. Interestingly for fluorescent powder, although there were no differences in developmental quality between the can sizes for Day 0, but for both Day 7 and Day 14, there were significant differences in the developmental quality between the small can and the large can (P < 0.05 for Day 7 and P < 0.001 for Day 14).

<table>
<thead>
<tr>
<th>Powder Type</th>
<th>Small Can (1 g powder)</th>
<th>Medium Can (4 g Powder)</th>
<th>Large Can (7 g Powder)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey</td>
<td>3.9 +/- 0.5</td>
<td>4.2 +/- 0.3</td>
<td>3.9 +/- 0.7</td>
</tr>
<tr>
<td>White</td>
<td>4.3 +/- 0.3</td>
<td>4.1 +/- 0.6</td>
<td>4.1 +/- 0.4</td>
</tr>
<tr>
<td>Black</td>
<td>2.1 +/- 0.6</td>
<td>2.0 +/- 0.5</td>
<td>2.0 +/- 0.7</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>3.0 +/- 0.7</td>
<td>3.2 +/- 0.7</td>
<td>3.1 +/- 0.7</td>
</tr>
</tbody>
</table>

Table 5
An overall comparison of the developmental quality of the impressions on Day 0 using various can sizes for each particular powder (95% confidence).

<table>
<thead>
<tr>
<th>Powder Type</th>
<th>Small Can (1 g powder)</th>
<th>Medium Can (4 g Powder)</th>
<th>Large Can (7 g Powder)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey</td>
<td>3.0 +/- 0.8</td>
<td>3.1 +/- 1.0</td>
<td>3.4 +/- 0.8</td>
</tr>
<tr>
<td>White</td>
<td>3.2 +/- 0.8</td>
<td>3.3 +/- 0.7</td>
<td>3.5 +/- 0.6</td>
</tr>
<tr>
<td>Black</td>
<td>1.4 +/- 0.5</td>
<td>1.2 +/- 0.5</td>
<td>1.5 +/- 0.4</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>2.3 +/- 0.5</td>
<td>2.9 +/- 0.7</td>
<td>3.2 +/- 0.7</td>
</tr>
</tbody>
</table>

Table 6
An overall comparison of the developmental quality of the impressions on Day 7 using various can sizes for each particular powder (95% confidence).

<table>
<thead>
<tr>
<th>Powder Type</th>
<th>Small Can (1 g powder)</th>
<th>Medium Can (4 g Powder)</th>
<th>Large Can (7 g Powder)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grey</td>
<td>2.8 +/- 0.9</td>
<td>2.9 +/- 0.9</td>
<td>3.1 +/- 0.7</td>
</tr>
<tr>
<td>White</td>
<td>2.5 +/- 0.9</td>
<td>3.2 +/- 0.9</td>
<td>3.0 +/- 0.8</td>
</tr>
<tr>
<td>Black</td>
<td>1.0 +/- 0.5</td>
<td>1.1 +/- 0.5</td>
<td>1.6 +/- 0.7</td>
</tr>
<tr>
<td>Fluorescent</td>
<td>1.7 +/- 0.7</td>
<td>2.5 +/- 0.6</td>
<td>3.4 +/- 0.5</td>
</tr>
</tbody>
</table>

Table 7
An overall comparison of the developmental quality of the impressions on Day 14 using various can sizes for each particular powder (95% confidence).
Deposition Age

A comparison of the quality of the impressions developed at different ages indicates decreasing developmental quality as the age of the impression increases. Overall, Day 0 had an average rating of 3.3 +/- 0.2, Day 7 had an average rating of 2.7 +/- 0.2, and Day 14 had an average rating of 2.4 +/- 0.2. The difference in developmental quality between Day 0 and Day 7 was statistically significant ($P < 0.001$), but no statistical difference was observed between Day 7 and Day 14 (Figure 9).

![Figure 9](image)

**Figure 9**

*Images demonstrate quality of development of impressions developed with grey powder previously processed with CNA on lightly textured surface. Image A demonstrates the quality of Day 0. Image B demonstrates the quality of Day 7. Image C demonstrates the quality of Day 14.*

Effect on DNA

An analysis of the potential of the chemical propellant to adversely affect DNA revealed that the saturation of a buccal swab with the aerosolized powder at a distance of one inch from the nozzle did not present a destructive effect on the DNA.

Discussion

This study evaluated the application of fingerprint powders by means of an aerosol spray as a possible alternative to the traditional method of application. This evaluation was accomplished by examining the results of four different powders applied by various can sizes filled with specific powder masses to two nonporous substrates bearing sebaceous latent print impressions of varying deposition intensity (depletion series) and ages. Half of the impressions were processed using CNA prior to the application of the powder and the other half received no prior processing.
Although the results indicate that there was no significant difference in the rating for those impressions developed on either substrate for each age, other substrate types should be tested to determine whether similar results would be reached. These results should not be generalized because only two substrate types were evaluated.

In relation to the developmental capabilities of the different powders used in this study, it is interesting to note the drastic difference in the quality of the impressions developed with the black powder as compared to the remaining powders. This difference may be attributable to the powder composition and morphology of the individual particles, which is illustrated in Figures 10 and 11. In addition, the fluorescent powder exhibited moderate development overall that may be explained, in part, because the powder had a tendency to create speckling in and around the furrows of the impression, which may have contributed to the inferior quality when compared to the white and grey powders.

Figure 10

*Image on the left represents a commonly used commercial black powder under a polarized light microscope at 200 X magnification. Image on the right represents the initial sample of black powder applied from the aerosol can in this study under a polarized light microscope at 200 X magnification.*

Figure 11

*A representation of the initial sample of black powder applied from the aerosol can in this study under a stereomicroscope at approximately 60 X magnification.*
The effect of CNA processing prior to the application of the powders resulted in little to no development on occasion, whereas those impressions of the same age with no prior processing maintained discernible ridge detail. These results are counterintuitive and interesting thus warranting further research to better understand why these results were observed. Based on this observation, however, it appears this method would not be conducive for use in combination with CNA. This is not a significant drawback to the technique, however, because those items that can be processed with CNA are usually sent to the laboratory where more advanced methods to develop latent prints are available compared to powder.

Multiple deposition intensities were evaluated to determine the sensitivity of the powders to develop quality impressions. The quality of development declined for each successive deposition intensity to a statistically significant degree with the maximum quality for Deposition 1 and culminating with Deposition 3 (least amount of matrix available for development) maintaining a moderate level of quality development. These results come with no surprise because the developmental ability of powders hinges primarily on the amount of residue available to adhere.

Although three separate powder masses were tested, each from a different can size, these variables did not contribute to a significant difference in developmental quality, probably because all cans contained a similar powder-to-propellant ratio. However, the differences in the developmental quality of fluorescent powder (between the small and large cans), as noted in Tables 6 and 7, are interesting, but warrant further studies with particular emphasis on the possible factors that may have contributed to this result.

The age of the impression did seem to have an effect on the powders' ability to develop the impressions as shown by the statistically significant decline in the quality ratings from Day 0 to Day 14. This negative relationship between age and developmental quality is an expected finding considering the normal degradation process of the latent print residue to which the powders adhere. Day 14 impressions, however, were still developed with a moderate level of quality. From this observation it would appear this method would not be precluded from use on impressions exposed for a couple of weeks; however, it should be cautioned that normal environmental conditions may cause differences to a considerable degree when compared to the controlled laboratory settings of this study.
Considering the negative results obtained from the black powder and the visualization of the drastic differences in particle morphology and composition compared to another common brand of powder as shown in Figure 10, a follow-up evaluation of a separate brand of black powder (Forensics Source, Jacksonville, FL) was conducted. Upon consultation with the manufacturer following the analysis of the initial results listed in this study, additional samples of black powder were received in a small (1g) can. This follow-up evaluation was conducted and the results were analyzed according to the protocol listed in the Materials and Methods section.

Overall, this follow-up evaluation of black powder resulted in superior developmental quality having an average rating of 4.0 +/- 0.2 (95% confidence) regardless of substrate type, prior processing, deposition intensity, and age of the impressions. When analyzing the results based on prior processing with and without CNA, an average rating of 3.8 +/- 0.3 was obtained for impressions previously processed with CNA and an average rating of 4.3 +/- 0.2 was obtained for impressions not previously processed with CNA. Although these ratings indicate a high level of developmental quality, the differences due to the prior processing are statistically significant (P <0.01), indicating the prior processing had a negative effect to the subsequent powder development. It should be noted, however, the impressions previously processed with CNA developed as negative impressions when the new sample of black powder was applied. The negative impression allowed for the ridge detail to be distinguished, but the powder did not actually adhere to the latent print residue itself (Figure 12). This observation warrants further research into the underlying cause. Additionally, there was not a considerable difference in the quality of the impressions developed with the additional supply of black powder when distinguished by age and deposition intensity. The superior results obtained in this follow-up evaluation with the new sample of black powder compared with the results obtained with the initial sample of black powder highlights the significance of the type of powder used in this method (Figure 13). The average numerical ratings of the quality of the impressions developed (95% confidence) with this additional supply of black powder can be found in the appendix.
Lastly, the results also indicated no observable adverse effects on DNA. Therefore, it can be determined that the aerosolized powder may be considered a non-DNA destructive method of powder application that, if necessary, may be applied to other items of evidential and forensic significance without the risk of destroying potential DNA.

In light of the developments in this method, the application of powder by means of an aerosol spray was determined to be a simple and convenient process and may serve as a viable alternative to traditional methods of powder application. Provided there was no deviation from the instructions, it was very effective in controlling the amount of powder deposited on the substrate surface allowing for the powder to be evenly distributed. Although the initial spray did not immediately develop the impressions, the powders did reveal an outline of the impressions, which could then be fully developed after a light brushing using a fiberglass fingerprint brush each time. By using the isolation device, the powder was effectively contained, allowing it to settle around the area of interest, while also cutting down on the health risks of airborne powders. For the majority of sprays, a relatively equal distribution of powder was observed per spray, which was most likely because the cans were thoroughly shaken for 10 to 15 seconds prior to each spray. Failure to shake each can could result in an insufficient amount of powder being distributed, causing the use of additional sprays to compensate and increasing the risk of overdevelopment. Insufficient mixing of the components may have contributed to the inferior results of this technique in earlier uses of this technique, among other factors, such as powder type, powder size, propellant and powder ratio, and nozzle type.
Images demonstrate quality of development of impressions developed with the new sample of black powder on Day 0 on smooth surface. Image on left demonstrates the quality of impressions previously processed with CNA – note the powder did not adhere to the ridges. Image on right demonstrates the quality of impressions not previously processed with CNA.

Images demonstrate quality of development of impressions developed with the old and new samples of black powder on Day 0 on lightly textured surface with no prior processing with CNA. Image on left demonstrates the quality of impressions developed with the old sample of black powder. Image on right demonstrates the quality of impressions developed with the new sample of black powder.
Conclusion

From the results and observations of this study, it can be concluded that this method of applying fingerprint powder via aerosol spray may not be a favorable technique for the laboratory environment because of the availability of superior methods other than powder in most laboratories; however, this method may be a viable option for field use. This method of application is an effective and less challenging technique than the traditional powdering method, especially for the inexperienced. It controlled the amount of powder released while maintaining an even distribution on the surface, decreased the need for arbitrary brush contact with the surface by allowing the investigator to focus the powdering efforts to the location of the impression as revealed by the initial spray thereby lessening the chances of damage to the impression, and exhibited no adverse effects on DNA. Although this study has demonstrated the viability of applying powder via aerolized spray, additional research is warranted to obtain a greater understanding of how this method compares with traditional methods related to the quality of the fingerprints developed. Additional research is warranted using different substrates, powders, and fingerprints aged in non-laboratory environmental conditions.

Acknowledgment

The authors would like to thank those individuals who supported and contributed to this study: Enamelite, LLC, for engineering, packaging, and providing the aerosol delivery systems used in this study (Patent Pending); James Garcia, Trace Evidence Branch, United States Army Criminal Investigation Laboratory (USACIL), for his assistance with the microscopic examinations of powders used in this study; Jeffrey Fletcher and Rob Fisher, DNA Branch, USACIL, for their assistance in performing the DNA examinations; Forensics Source for providing the additional sample of black powder used in the follow-up evaluation; and the latent print examiners from the USACIL for their participation in this project.

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Disclaimer

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the United States Department of the Army or the United States Department of Defense.

Various products are listed not as an endorsement, but for purposes of reproducibility.

References

Appendix

### Day 0

<table>
<thead>
<tr>
<th>CNA Smooth</th>
<th>CNA Textured</th>
<th>No CNA Smooth</th>
<th>No CNA Textured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposition 1</td>
<td>3.8 +/- 0.5</td>
<td>4.4 +/- 0.4</td>
<td>4.8 +/- 0.3</td>
</tr>
<tr>
<td>Deposition 2</td>
<td>3.3 +/- 0.7</td>
<td>4.3 +/- 0.5</td>
<td>4.3 +/- 0.7</td>
</tr>
<tr>
<td>Deposition 3</td>
<td>3.1 +/- 0.5</td>
<td>4.3 +/- 0.5</td>
<td>5.0 +/- 0.0</td>
</tr>
</tbody>
</table>

The average numerical ratings of developmental quality for the black powder used in the follow-up evaluation for Day 0 impressions (95% confidence).

### Day 7

<table>
<thead>
<tr>
<th>CNA Smooth</th>
<th>CNA Textured</th>
<th>No CNA Smooth</th>
<th>No CNA Textured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposition 1</td>
<td>3.1 +/- 0.6</td>
<td>4.0 +/- 0.5</td>
<td>4.1 +/- 0.5</td>
</tr>
<tr>
<td>Deposition 2</td>
<td>3.0 +/- 0.7</td>
<td>4.2 +/- 0.6</td>
<td>4.6 +/- 0.4</td>
</tr>
<tr>
<td>Deposition 3</td>
<td>3.0 +/- 0.7</td>
<td>4.1 +/- 0.6</td>
<td>3.9 +/- 0.6</td>
</tr>
</tbody>
</table>

The average numerical ratings of developmental quality for the black powder used in the follow-up evaluation for Day 7 impressions (95% confidence).

### Day 14

<table>
<thead>
<tr>
<th>CNA Smooth</th>
<th>CNA Textured</th>
<th>No CNA Smooth</th>
<th>No CNA Textured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposition 1</td>
<td>3.8 +/- 0.6</td>
<td>4.2 +/- 0.5</td>
<td>4.2 +/- 0.6</td>
</tr>
<tr>
<td>Deposition 2</td>
<td>3.1 +/- 0.3</td>
<td>4.1 +/- 0.5</td>
<td>3.9 +/- 0.7</td>
</tr>
<tr>
<td>Deposition 3</td>
<td>3.3 +/- 0.5</td>
<td>4.3 +/- 0.4</td>
<td>3.7 +/- 0.5</td>
</tr>
</tbody>
</table>

The average numerical ratings of developmental quality for the black powder used in the follow-up evaluation for Day 14 impressions (95% confidence).